

RESEARCH ARTICLE

Pre-operative Functional Parameters of Patients Undergoing Total Knee Arthroplasty

Rafael Andrade Tambascia^{1*}, Rodrigo Antunes Vasconcelos², Wilson Mello², Paulo Portes Teixeira² & Debora Bevilaqua Grossi²

¹Program Performance and Functional Rehabilitation, Faculty of Medicine of Ribeirão Preto, University of São Paulo, Ribeirão Preto, São Paulo, Brazil

²Center for Studies and Research, Instituto Wilson Mello, Campinas, São Paulo, Brazil

Abstract

Background and purpose. Total knee arthroplasty (TKA) has become the gold standard to manage pain and disability associated with knee osteoarthritis (KOA). There are no clear criteria on to determine when or who should undergo TKA. The creation of a pre-operative profile that includes physical functional data may aid in the clinical decision-making for the timing of TKA. Aim 1: to observe the pre-operative functional profile of subjects with advanced KOA and to depict it according to gender. Aim 2: to assess the association between pain, self-reported and performance-based physical function outcomes. **Materials and methods.** Study design: retrospective study. Physical functional data from 122 persons (89 women and 33 men) with end-stage KOA were obtained through a database. Data consisted of height, weight, 6-minute walk test (6MWT) and the deficit when compared with normative values, self-visual analogue scale (VAS) after 6MWT and Western Ontario and McMaster Universities Index (WOMAC). Descriptive statistics were used to report the observed data; student *t*-test and Mann–Whitney were used to compare gender groups. Spearman correlation was used to assess the association with the 6MWT, WOMAC and VAS. **Results.** The mean (standard deviation) values of our sample for the WOMAC, 6MWT deficit and VAS were calculated. There was a significant difference between gender in the WOMAC score and pain intensity (VAS) after the 6MWT ($p=0.002$; $p=0.01$). Moderate to weak correlations between WOMAC score, VAS and 6MWT were found. Correlation values ranged from $r=0.23$ to 0.48 . **Conclusion.** The current study suggests a functional profile for subjects who are scheduled to undergo TKA. Our results show that the correlations of self-report and performance-based measures of function and reported pain are poor. This enhances the idea of using all of these types of measures to establish the functional profile a sample of subjects with advanced KOA. Copyright © 2015 John Wiley & Sons, Ltd.

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*Correspondence

Rafael Andrade Tambascia, Program Performance and Functional Rehabilitation, Faculty of Medicine of Ribeirão Preto, University of São Paulo, Ribeirão Preto, São Paulo, Brazil.

Email: rtambascia@iwmello.com.br

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Introduction

The total knee arthroplasty (TKA) is considered an important procedure in reducing pain and improving the quality of life in the short-term and long-term around 90% of patients with advanced osteoarthritis (OA) (Heck *et al.*, 1998; National Institutes of Health, 2003; Stratford *et al.*, 2004). Today, TKA is recognized as the most cost-effective procedures for patients with advanced osteoarthritis, with approximately 516,000 arthroplasties being performed in the United States, and a projection to 3.48 million in 2030 (Kurtz *et al.*, 2007).

Currently, to our knowledge, there are no established criteria of functional performance variables that would serve as criteria of indication of TKA (Gossec *et al.*, 2007). The variables of physical performance and self-reported functional questionnaires are widely used and described in the literature to measure outcomes in TKA research; however, such variables have not been described as a functional criterion to the indication of the TKA (Fortin *et al.*, 1999; Jones *et al.*, 2003; Bourne *et al.*, 2007). We believe that comparing functional results with a pre-established functional criteria can help the clinician in the decision-making process to better decide the indication for TKA.

One criterion that is used is the imaging exams as reduced joint space and the presence of osteophytes are both considered the main aspects to determine the indication for arthroplasty. It is also indicated for disability, pain, limited function from osteoarthritis, rheumatoid arthritis and any type of arthritic deformity or when persistent pain occurs after all conservative treatment measures have been exhausted (Van Manen *et al.*, 2012).

However, it is established that the image does not correlate with symptoms, impairments and the disability shown by patients with advanced OA (Vasconcelos *et al.*, 2006; Toivanen *et al.*, 2007).

We hypothesize that in addition to the images, variables obtained from physiotherapy functional assessments should add information that is more relevant in clinical aspect. The number of TKAs is increasing coupled with the rise in the proportion of OA and older population (Kennedy *et al.*, 2002). Our rationale is that TKA is over indicated, so adding functional parameters will be able to identify patients who need TKA better and who are likely to respond to a physical

therapy. Consequently, the number of procedures could reduce significantly. Also, physical therapists can use this information to better direct his interventions when the conservative treatment is chosen.

Differences between genders are also well described in the literature concerning OA and indications for TKA. The prevalence of OA is higher for women than men, as well as worse symptoms and grater disability. Despite an equal willingness to undergo surgery, women have had less arthroplasty compared with men (Hawker *et al.*, 2000). Karlson *et al.*, (1997) found that women are more willing to accept impairments caused by OA than men, leading to a poor function before considering TKA. This suggests that functional tests and self-reported questionnaires should be evaluated separately between genders.

The functional aspects seen in patients with knee OA may be influenced by pain, swelling, weakness, stiffness and the difficulty in performing specific functional tasks (Stratford *et al.*, 2004; Stratford *et al.*, 2006). Previous studies using the results of self-reported functional questionnaires as predictive factors for TKA claim that the use alone of these variables does not reproduce the exact functional status of the individual and that they should be evaluated in conjunction with tests of physical performance (Hidding *et al.*, 1994; Hawker *et al.*, 2001; Hawker *et al.*, 2006). According to Mizner *et al.*, (2005), patients undergoing TKA have difficulty differentiating pain to the skills to perform functional tasks, which suggests the need for a thorough evaluation involving all the mentioned perceptual aspects of self-reported pain and function and physical performance.

To our knowledge, there are few studies that looked at these variables in patients at the pre-operative planning phase of TKA. The studies that presented this type of data did not perform these evaluations in order to characterize the clinical profile of the patient who will undergo TKA (Fortin and Clarke, 2002; Mizner *et al.*, 2005). Taking this profile into consideration together with the imaging exams could help in the decision-making for TKA. We consider the actual criteria incomplete due to our experience with patients who have poor image, reported pain, limited function, Range of Motion (ROM) and stiffness but good performance in functional tests as 6-minute walking test (6MWT).

Therefore, the primary aim of this study was to compare between genders parameters of physical functional performance, self-reported physical

function and reported pain in patients with advanced knee OA with indication for TKA. A secondary aim was to evaluate the correlation between self-reported function and physical performance variables in patients undergoing TKA.

Methods

We identify 140 medical records to be analysed. We excluded 18 (12%) records that contained incomplete information about demographics data, other musculoskeletal disorders that could influence physical performance and self-reported function reports, patients with uncontrolled hypertension, neoplasms, diabetes mellitus, neurological disorders such as multiple sclerosis or Parkinson's disease, body mass index or BMI over 40 (morbid obesity). The medical records were also excluded from patients who present pain between 4 and 10 (visual analogue scale) in the contralateral knee or who had planned for bilateral TKA within the same year of the functional assessment date. The study was retrospective and involved the analysis of medical records of 122 patients, 89 women and 33 men, identified in Wilson Mello Institute (private institution) in Campinas, SP, Brazil, from October 2009 to December 2011. The records that were included in the study contained information from subjects who underwent clinical evaluation by the same orthopaedic physician, who after confirming the clinical diagnosis of knee OA gave absolute indication for TKA. Also included in the records, all subjects had a report of the functional assessment of the knee, which contained demographic data, the visual analogue scale (VAS) and WOMAC scores and results of the 6MWT. This study was approved by the ethics committee/protocol 919/11.

General procedures

The chart reviews were performed by a single investigator who selected all the charts of the subjects who fit the inclusion/exclusion criteria. The same person manually entered the data into a computer. Once the data set was completed, the data were exported to statistical software (SAS version 9.2, SAS Institute Inc., Cary, NC, USA) where a different person was responsible to run the analysis.

Functional assessment details and procedures

All of the measurements were performed as part of a functional assessment evaluation that is offered once the TKA is indicated. The assessment visit was conducted by one of the three evaluators responsible for the evaluation. All three evaluators were physical therapists trained by the same instructor on how to perform the assessment. Our own research group has verified the intra and inter-tester reliability of tests involved in the assessment, and it has proved to be acceptable (data not published).

The assessment protocol consisted in collecting history and demographic data, WOMAC questionnaire and 6MWT. The WOMAC is a self-reported instrument that includes 24 questions divided into three sections: 1) pain (five questions); 2) stiffness (two questions); and 3) physical function (17 questions). The pain category assesses pain elicited during activities of daily living, while the stiffness category assesses the amount of stiffness elicited after staying in certain positions and the time of day it is experienced. The physical function category measures the patients' ability to perform certain activities including going from sit to stand, walking, stair negotiation, putting on socks and so on. The WOMAC version used was translated to Portuguese by Fernandes (2003). The WOMAC total score is determined by combining the scores from all three sections. In the translated version, lower scores represent greater problems with pain and function. For example, if someone scores 98 points at WOMAC total score that would represent no loss of function, disability and pain. It has been well documented that the WOMAC is reliable, valid and responsive to change in patients with hip and knee OA (Fernandes, 2003).

For the 6MWT, subjects were instructed to walk from one end to the other of an 8-m long by 1-m wide hallway within a dedicated room for it at their own pace while attempting to cover as much ground as possible in the allotted 6 minutes. Evaluators encouraged subjects with the standardized statements as 'You're doing well' or 'Keep up the good work' but were asked not to use other phrases. At the end of 6 minutes, the number of turns was recorded for the calculation of distance, and the perception of pain was asked by the evaluator, and the subject was given a VAS where one extremity represented 'no pain' and the opposite mean 'worst pain possible'. The patients pointed the pain

located in the VAS, and the therapist matched that position to a number in the backside of the scale from 0 to 10.

Data analysis

The variables analysed included gender, age, BMI, duration of symptoms, 6MWT and VAS pain scores in the WOMAC questionnaire.

For the 6MWT, the distance covered by the subjects was compared with the minimum ideal walking distance for healthy subjects calculated using formulas developed by Enright and Sherril (1998), in which for men, the formula $6MWD = (7:57 \times \text{height in cm}) - (2.5 \times \text{age}) - (1.76 \times \text{weight in kg}) - 309 \text{ m}$ and for women, $6MWD = (2.11 \times \text{height in cm}) - (2.29 \times \text{weight in kg}) - (5.78 \times \text{age}) + 667 \text{ m}$. From this comparison of the minimum ideal walking distance and actual distance covered by the research subject, a deficit was calculated using the formula $\text{Deficit} = (\text{distance travelled/ideal minimum distance}) \times 100$.

For each variable, we described the mean, standard deviation, median and 95% confidence interval. The quantitative results were evaluated for distribution through the Kolmogorv–Smirnov test. For the normal distribution, we compared the results between genders, through the student *t*-test; otherwise, we used the non-parametric Mann–Whitney test. For the study's secondary aim, the Pearson correlation index was used between the physical performance test (6MWT) and self-reported variables (WOMAC and VAS). The significance level was 5%, and the software used for analysis is the SAS version 9.2.

Results

We evaluated charts of 192 patients; after applying the exclusion criteria, we selected 122 records for the study (89 women and 33 men) with a mean age of 68.2 years, standard deviation (8.3) and mean BMI of 29.4. Table 1 presents the socio-demographic variables with confidence intervals and the duration of symptoms, according to gender. Despite the differences in height and weight, groups did not differ in BMI.

The functional variables are shown in Table 2. For the WOMAC scores, there was a significant difference between genders ($p = 0.0002$) with no overlapping of the 95% confidence interval (women 46.6–54 and men 58.3–68.7). The 6MWT showed a significant difference in performance between genders ($p = 0.0029$) and in the calculation of the minimum ideal distance ($p < 0.0001$). The calculation of the deficit on the walking test did not show any significant difference between genders ($p = 0.8218$). The perception of pain assessed at the end of the walk test shows that women have a higher perception of pain than men ($p = 0.0186$).

The correlations of 6MWT with the self-reported variables are shown in Table 3. Data analysis revealed that the higher the WOMAC score (higher function), the better performance in the 6MWT and the lower the 6MWT deficit. As for the VAS, the greater was the performance on the walking test, the lower was the perception of pain and the lower was the 6MWT deficit. Although the correlations values were significant, they can be considered as weak to moderate correlations (Callegari-Jacques, 2003).

Table 1. Comparison between genres of socio-demographic variables and duration of symptoms

Variables	Women <i>n</i> = 89				Men <i>n</i> = 33				<i>p</i> value
	Mean	SD	95% CI		Mean	SD	95% CI		
			Upper bounder	Lower bounder			Upper bounder	Lower bounder	
Age	68.8	8.0	67.1	70.5	66.4	8.7	63.4	69.5	0.1551*
Weight	76.2	14.0	73.2	79.1	88.8	13.8	83.9	93.6	<0.0001
Height	160.9	6.1	159.7	162.2	172.9	7.9	170.1	175.7	<0.0001
Body mass index	29.4	5.0	28.3	30.4	29.6	3.1	28.5	30.7	0.7756*
Duration of symptoms (months)	49.1	46.3	39.4	58.9	60.7	60.2	39.3	82.0	0.3478

Mann–Whitney test.

*Student *t*-test.

SD = standard deviation; CI = confidence interval.

Table 2. Comparison of self-reported variables (Western Ontario and McMaster Universities Index and visual analogue scale) and physical performance (6MWT), according to gender

Variable	Women <i>n</i> = 89				Men <i>n</i> = 33				<i>p</i> value
	Mean	SD	95% CI		Mean	SD	95% CI		
			Upper bounder	Lower bounder			Upper bounder	Lower bounder	
WOMAC	50.3	17.5	46.6	54.0	63.5	14.7	58.3	68.7	0.0002*
6MWT	296.4	132.5	268.5	324.4	376.7	122.1	333.5	420.0	0.0029*
6MWT Minimum Ideal Distance	408.9	77.4	392.6	425.2	510.3	71.0	485.1	535.4	<0.0001*
Deficit 6MWT	-0.27	0.33	-0.34	-0.20	-0.26	0.24	-0.34	-0.17	0.8218*
VAS	5.0	2.9	4.4	5.6	3.7	2.4	2.8	4.6	0.0186

Mann-Whitney test.

*Student *t*-test.

WOMAC = Western Ontario and McMaster Universities Index; VAS = visual analogue scale; 6MWT = 6-minute walk test; SD = standard deviation; CI = confidence interval.

Table 3. Pearson correlation between functional performance and self-reported variables

	WOMAC	VAS
6MWT	0.357*	-0.488*
6MWT minimum ideal distance	0.253*	-0.237*
Deficit 6MWT	-0.290*	0.411*

**p* < 0.05.

WOMAC = Western Ontario and McMaster Universities Index;

VAS = visual analogue scale; 6MWT = 6-minute walk test.

Discussion

The primary aim of this study was to compare between genders parameters of physical functional performance, self-reported physical function and reported pain in patients with advanced knee OA with indication for TKA. Our results showed that men and women differ in self-reported pain and functional limitation (measured by the WOMAC) even when they present the same deficit in the walking test. A secondary aim was to evaluate the correlation between self-reported function and physical performance variables in patients undergoing TKA. We found that the performance-based variables showed to be moderately correlated with the self-reported perception of function and pain. We were able to observe a functional profile of the type of patient that has an indication for TKA. We believe that this observed profile may reflect a functional status that could potentially be considered in the decision-making process of TKA in combination with imaging and clinical exams.

Our sample was comparable to other studies for the demographic variables (Manninen et al, 1996; Vasconcelos et al, 2006). The duration of symptoms showed a high standard deviation with a minimum of at least 36 months of symptoms; however, it did not show differences between the genders. To our knowledge, there has been no study that evaluated chronicity as a major influence in determining TKA.

In our study, we evaluated the pain at the end of the 6MWT to try to minimize the effects of central sensitization and low pain threshold than patients of advanced OA have (Arendt-Nielsen et al, 2010; Leah, 2012). The rationale was to evaluate the pain generated right after the mechanical stimulation. Thus, we find lower values compared with some studies that showed levels of *pain* > 5 on a visual analogue scale (Walsh et al, 1998; Stratford et al, 2006; Szebenyi et al, 2006; Brander et al, 2007). There was a statistically significant difference regarding pain perception between genders with women higher levels of reported pain compared with men. Regarding performance on the 6MWT, we opted to use the equations (Enright and Sherril, 1998) for each gender to determine the deficit in the 6MWT that OA patients have in relation to a healthy physical profile similar to his. We found no significant differences between genders in the deficit of the 6MWT suggesting that they had the same level of disability regardless of their pain perception.

It was expected that women reported higher pain levels as was shown in this study and that this higher reported pain was associated with greater disability confirmed by the WOMAC. However, despite the pain and function reported by women suggest that they may

have greater impairments than men with advanced OA, the evaluation of physical performance measured by the deficit in the 6MWT revealed that there is no difference between genders in that aspect. This finding may reinforce the need to measure both self-reported and performance-based function. Our results showed that the correlations between the variables of performance and reported pain and disability, despite being considered statistically significant, were considered as weak to moderate correlations according to reported correlation classifications.

For example, our results showed a poor correlation between WOMAC and 6MWT. Considering our experience, we thought that this finding was somewhat expected. The 6MWT is a performance-based functional test that assesses gait only in a controlled environment with no distractions or real life situations. On the other hand, the WOMAC score is a self-reported functional measured that assesses the difficulty, presence of stiffness and intensity of pain during several different functional activities such as sitting, standing, walking and stairs. Another reason for this poor correlation could be that this finding reinforces both assessment tools are necessary to determine the functional profile of this patient. Some studies have also showed poor correlations between the WOMAC scores and physical performance tests in patients after TKA (Parent and Moffet, 2002; Stratford *et al.*, 2004).

A potential limitation of our study could be the socio-economic profile of the study population that may influence some parameters because of better access to treatment resources and less waiting time for procedures and care. Future studies using other samples with different economic profiles can provide information if the results of our data may apply to all social classes. Therefore, larger randomized, controlled trials can confirm the results and statistical patterns found in our study and can provide references of functional parameters that would assist in the decision-making process of TKA.

Conclusion

According to the analysed data, both genders showed similar physical limitations at the expense of an advanced OA. Regarding self-perception function and pain, women seem to report higher levels of pain and higher disability than men. Although women report

greater pain and disability, the deficit of the 6MWT was not different between genders. The correlations between variables were significant but considered weak and moderate suggesting the combined use of both criteria for better quality of functional analysis.

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